# Occupational Injury Deaths of 16- and 17-Year-Olds in the United States

*Dawn N. Castillo, MPH, Deborah D. Landen, MD, MPH, and Larry A. Layne, MA*

## ABSTRACT

Data from the National Traumatic Occupational Fatalities surveillance system were used to analyze occupational injury deaths of civilian 16- and 17-year-olds during 1980 through 1989. There were 670 deaths; the rate was 5.11 per 100 000 full-time equivalent workers. The leading causes of death were incidents involving motor vehicles and machines, electrocution, and homicide. Workers 16 and 17 years old appear to be at greater risk than adults for occupational death by electrocution, suffocation, drowning, poisoning, and natural and environmental factors. Improved enforcement of and compliance with federal child labor laws, evaluation of the appropriateness of currently permitted activities, and education are encouraged. (*Am J Public Health.* 1994;84:646–649)

## *Introduction*

Although several studies have examined nonfatal occupational injuries among youth,[1–8] only one published study has investigated occupational injury deaths of young people across the United States. Suruda and Halperin analyzed data from Occupational Safety and Health Administration (OSHA) fatality investigations between 1984 and 1987.[9] Of the 104 deaths investigated, 30% involved industrial vehicles and equipment, 17% were electrocutions, and 11% resulted from falls. Thirteen percent of the fatally injured youth were 15 years of age or younger.

Analysis of OSHA fatality investigations does not present a complete picture of occupational injury death in the United States, however. OSHA investigates only about 25% of work-related deaths, most of which are concentrated in the construction and manufacturing industries.[9] OSHA does not investigate homicides, most transportation incidents, and industries regulated by other federal agencies such as the Mine Safety and Health Administration and the Department of Transportation.

To obtain a more comprehensive picture of occupational injury deaths among youth, we analyzed data from the National Traumatic Occupational Fatalities surveillance system. This surveillance system is not limited by the industry or occupation in which the death occurred and includes all causes of occupational injury death. Because the minimum age included in the system is 16 years, the analysis was limited to 16- and 17-year-olds.

## *Methods*

Data from the National Traumatic Occupational Fatalities surveillance system were used to analyze occupational injury deaths of 16- and 17-year-olds—and, for comparison, adults 18 years of age and older—for the years 1980 through 1989 (the most recent years for which data are available). This ongoing surveillance system, maintained by the National Institute for Occupational Safety and Health, includes information from death certificates for all work-related injury deaths reported by the 52 vital statistics reporting units in the United States (the 50 states, New York City, and the District of Columbia). To be included in the system, death certificates must meet the following criteria: the victim was at least 16 years of age; the death was attributed to an external cause (i.e., injury or poisoning), as designated by the *International Classification of Diseases*, ninth revision (ICD-9)[10]; and the certifier responded positively to the "injury at work" item on the death certificate. Information from the immediate, contributory, and underlying cause of death and injury description fields on the death certificate was used to code the external causes of death (ICD-9 codes E800 through E999). The industry division was coded from the "usual industry" field on the death certificate according to the *Standard Industrial Classification Manual, 1987.*[11]

For calculation of rates, data on hours worked were obtained from the Bureau of Labor Statistics' Current Population Survey, a monthly survey of US households selected from a probability sample representative of the civilian noninstitutional population.[12] For each age group, average hours worked were converted to full-time equivalent workers by multiplying the average number of hours worked per week by 52 weeks per year and dividing by 2000 (the average number of hours worked per year).

The authors are with the Division of Safety Research, National Institute for Occupational Safety and Health, Morgantown, WV.

Requests for reprints should be sent to Dawn N. Castillo, MPH, Division of Safety Research, National Institute for Occupational Safety and Health, 944 Chestnut Ridge Rd, MS 180, Morgantown, WV 26505.

This paper was accepted October 4, 1993.

**Editor's Note.** See related editorials by Pless (p 537) and Kaufer Christoffel (p 539) in this issue.

**TABLE 1—Industry Division of 16- and 17-Year-Old Youth Who Died from Occupational Injury: United States, 1980 through 1989**

| Industry Division | Deaths |
|---|---|
| Not classified | 316 |
| Agriculture, forestry, and fishing | 110 |
| Construction | 59 |
| Services | 56 |
| Retail trade | 42 |
| Manufacturing | 34 |
| Transportation and public utilities | 25 |
| Mining | 14 |
| Wholesale trade | 10 |
| Public administration | 3 |
| Finance, insurance, and real estate | 1 |
| Total | 670 |

*Note.* Because information on industry was available for only 53% of the fatally injured youth, interpretation should be restricted to identifying the minimum number of deaths within each industry division.

**TABLE 2—Distribution and Rates of Occupational Injury Death, by Cause, for 16- and 17-Year-Olds and Adults 18 Years of Age and Older: United States, 1980 through 1989**

| | 16- and 17-Year-Olds | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Total | | Adults | | Rate Ratio[b] |
| | Deaths | Rate[a] | Deaths | Rate | Deaths | Rate | Deaths | Rate | |
| Motor vehicle related | 149 | 2.05 | 13 | 0.22 | 162 | 1.24 | 14 113 | 1.41 | 0.88 |
| Machine related | 105 | 1.44 | 8 | 0.14 | 113 | 0.86 | 8388 | 0.83 | 1.04 |
| Electrocution | 78 | 1.07 | 2 | ND | 80 | 0.61 | 4384 | 0.43 | 1.42 |
| Homicide | 46 | 0.63 | 18 | 0.31 | 64 | 0.49 | 7512 | 0.75 | 0.65 |
| Falls | 37 | 0.51 | 1 | ND | 38 | 0.29 | 5941 | 0.59 | 0.49 |
| Struck by falling object | 31 | 0.43 | 0 | ND | 31 | 0.24 | 4103 | 0.41 | 0.59 |
| Suffocation | 29 | 0.40 | 0 | ND | 29 | 0.22 | 1175 | 0.12 | 1.83 |
| Drowning | 24 | 0.33 | 1 | ND | 25 | 0.19 | 869 | 0.09 | 2.11 |
| Poisoning | 20 | 0.28 | 0 | ND | 20 | 0.15 | 985 | 0.10 | 1.50 |
| Natural and environmental | 15 | 0.21 | 2 | ND | 17 | 0.13 | 758 | 0.08 | 1.63 |
| Other | 83 | ... | 8 | ... | 91 | ... | 12 941 | ... | ... |
| All causes | 617 | 8.49 | 53 | 0.91 | 670 | 5.11 | 61 169 | 6.09 | 0.84 |

*Note.* ND = not determined because of instability of rates based on small numbers.
[a]Rate per 100 000 full-time equivalents (FTE). The employment figures used in calculation of rates for 16- and 17-year-olds were 7 270 705 male FTE, 5 837 621 female FTE, and 13 103 732 total FTE. The employment figure for adults was 1 000 000 000 FTE.
[b]16- and 17-year old occupational injury death rate/adult rate.

Rates of occupational injury death were calculated per 100 000 full-time equivalent workers.

## *Results*

There were 673 occupational injury deaths to 16- and 17-year-olds for the 10-year period from 1980 through 1989. Military personnel accounted for 3 of these deaths (young people 17 years of age may enter the military with permission from their parents). These military cases were removed from further analysis because comparable employment data for military personnel were not available. The average annual rate of occupational injury death for 16- and 17-year-olds was 5.11 per 100 000 full-time equivalent workers; the rate for adults 18 years of age and older was 6.09 per 100 000.

Two hundred ninety-seven (44%) of the deaths occurred during the summer months (June through August). There were 143 deaths (21%) during September through November and approximately 100 deaths each during the winter and spring months.

There were 429 deaths involving 17-year-olds and 241 deaths involving 16-year-olds; 617 of the victims were male. Most of the victims (540) were White; 62 were Hispanic, 53 were Black, and 15 were of other or unknown race/ethnicity.

The rates of occupational injury death of 16- and 17-year-olds dropped from 7.16 per 100 000 full-time equivalent workers in 1982 to 3.94 per 100 000 in 1983 and have been stable since. The rate in 1989 was 3.67 per 100 000 full-time equivalent workers.

Occupation and industry information was not available for most cases. The "usual occupation" for 388 (58%) of the fatally injured youth was reported to be "student." Table 1 provides the frequency of deaths by industry division. Because industry was available for only 354 (53%) of the fatally injured youth, the interpretation of these data should be restricted to identifying the minimum number of deaths within each division.

The distribution of occupational injury deaths by cause and rates for each cause are presented in Table 2 for 16- and 17-year-olds and, for comparison, adults 18 years of age and older. The leading causes of occupational injury death for both age groups were incidents involving motor vehicles and machines. Although the overall risk of occupational injury death is lower for 16- and 17-year-olds than for adults, the risk for occupational injury death by electrocution, suffocation, drowning, poisoning, and natural and environmental causes appears to greater for young people than for adults (14 of the 17 youths who died from natural and environmental causes were struck by lightning).

Motor vehicles accounted for nearly 25% of the occupational injury deaths of 16- and 17-year-olds. Thirty-three percent (53) of the fatally injured youth were driving a motor vehicle, 17% (28) were passengers, and 20% (32) were pedestrians. Information included on the death certificate was insufficient to determine whether the fatally injured youth was a driver, passenger, or pedestrian in 28% (46) of the deaths involving motor vehicles.

Agricultural machinery accounted for 68% of the machine-related deaths; tractors accounted for 44% of the machine-related deaths. Of the 50 tractor-related deaths, at least 29 were caused by rollovers, and 4 were a result of the individual's being run over; power takeoffs contributed to at least 3 of the deaths.

Events leading to electrocution could not be determined for nearly 30% of the electrocutions. Contact with an energized power line was the most frequent cause, accounting for 55% (44) of electrocutions.

## Discussion

Although the National Traumatic Occupational Fatalities surveillance system is the best available source of information on occupational fatalities in the United States for the period of this study, it has limitations. Identification of work-related injury deaths and appropriateness of occupation and industry information on the death certificate are the primary issues. In a review of 10 studies that used multiple sources to identify the universe of fatal work-related injuries, Stout and Bell reported that, on average, death certificates captured 81% of work-related injury deaths.[13] Thus, frequencies and rates presented in this paper should be considered conservative estimates. Studies have demonstrated agreement of 60% to 76% between "usual industry" and "usual occupation" entries on the death certificate and employment at the time of death.[14] On the basis of the high percentage of young people whose occupation was listed as "student" in this analysis, the correspondence appears to be poorer for youth. Jenkins et al. provide a thorough discussion of the methodology and limitations of the National Traumatic Occupational Fatalities surveillance system.[15]

Although occupational injury deaths declined in the early part of the decade, exposure to hazardous work environments remains a problem. The primary law designed to protect young people from adverse effects of employment is the Fair Labor Standards Act of 1938. The act sets minimum age standards for employment, limits hours and occupations in which 14- and 15-year-olds may work, defines occupations and tasks that are hazardous, and proscribes hazardous work for nonagricultural workers under 18 years of age[16] and agricultural workers under 16 years of age.[17] There are numerous exemptions to the act, the most notable being that children may work on the family farm at any age, at any time, and in any occupation, including work declared to be hazardous. In addition to the protection provided by federal law, all but four states—Colorado, Kansas, Maryland, and Mississippi—have child labor laws.[18]

The lack of detailed information available from death certificates precluded the enumeration of deaths in the National Traumatic Occupational Fatalities system resulting from activities permitted and not permitted under the Fair Labor Standards Act. Motor vehicle driving, which resulted in the deaths of at least 53 young people, is prohibited for nonagricultural workers under 18 years of age. Suruda and Halperin reported that 41% of occupational injury deaths of youth investigated by OSHA occurred while the child was engaged in work prohibited by federal child labor laws.[9] The small number of child labor inspectors and inadequate penalties have been cited as reasons for the persistence of child labor violations.[6,18] Increased coordination between OSHA and federal and state labor departments[9,19] and increased penalties sufficient to deter violations have been recommended as ways to improve enforcement and compliance with child labor laws.[19]

At least 110 of the fatally injured youth worked in the agriculture, forestry, and fishing industry. The Fair Labor Standards Act declares that operation of several types of agricultural machines, including tractors of more than 20-power-takeoff horsepower, is hazardous for those younger than 16 years of age. The appropriateness of hazardous agricultural work for young people deserves evaluation. Legislation recently enacted in Virginia that raised the minimum age from 16 to 18 for several hazardous agricultural occupations[20] should be evaluated. Formal training in the safe operation of farm equipment and the installation of protective devices, such as rollover protective structures, may also reduce the incidence of injury to children.

The appropriateness of youth employment in the construction industry should also be evaluated. The construction industry has the second highest rate of occupational injury death among workers of all ages[15] and contributed to the deaths of at least 59 young people.

In addition to regulation and enforcement, there is a role for education in preventing occupational injury of youth.[6] Young people, parents, teachers and school boards, physicians, and the business community must be educated about child labor laws and the risks of injury in the workplace. Youth and their parents require this information to make informed decisions about appropriate jobs for young people. Teachers, school boards, and physicians should consider these issues when dispensing work permits. The business community needs to be aware of its responsibilities under the law to protect youth in its employ and to understand the potential for tragedy related to noncompliance with existing laws.

This study of death certificate data has identified the leading causes of occupational injury death of 16- and 17-year-olds and examined differences in risk between youth and adults by external cause of death. Additional research is needed to understand the circumstances under which young people die from injuries incurred while working and to identify ways in which such deaths can be prevented. Epidemiologic data addressing the effect of training, job experience, supervision, job stressors, work permits, and child labor laws on the risk for occupational injury death of youth are needed. □

## References


1. Brooks DR, Davis LK, Gallagher SS. Work-related injuries among Massachusetts children: a study based on emergency department data. *Am J Ind Med.* 1993;24:313–324.
2. Belville R, Pollack SH, Godbold JH, Landrigan PJ. Occupational injuries among working adolescents in New York State. *JAMA.* 1993;269:2754–2759.
3. Banco L, Lapidus G, Braddock M. Work-related injury among Connecticut minors. *Pediatrics.* 1992;89:957–960.
4. Heyer NJ, Franklin G, Rivara FP, Parker P, Haug JA. Occupational injuries among minors doing farm work in Washington State: 1986 to 1989. *Am J Public Health.* 1992;82:557–560.
5. Parker DL, Clay RL, Mandel JH, Gunderson P, Salkowicz L. Adolescent occupational injuries in Minnesota: a descriptive study. *Minn Med.* 1991;74:25–28.
6. Pollack SH, Landrigan PJ, Mallino DL. Child labor in 1990: prevalence and health hazards. *Annu Rev Public Health.* 1990;11:359–375.
7. Schober SE, Handke JL, Halperin WE, Moll MB, Thun MJ. Work-related injuries in minors. *Am J Ind Med.* 1988;14:585–595.
8. Coleman PJ, Sanderson LM. Surveillance of occupational injuries treated in hospital emergency rooms—United States, 1982. *MMWR.* 1983;32:31SS–37SS.
9. Suruda A, Halperin W. Work-related deaths in children. *Am J Ind Med.* 1991;19:739–745.
10. *International Classification of Diseases: Manual on the International Statistical Classification of Diseases, Injuries, and Causes of Death, Ninth Revision.* Geneva, Switzerland; World Health Organization; 1977.
11. *Standard Industrial Classification Manual, 1987.* Washington, DC: Office of Management and Budget; 1987.
12. *BLS Handbook of Methods.* Washington, DC: US Dept of Labor; 1988. Bulletin 2285.
13. Stout NS, Bell CA. Effectiveness of source documents for identifying fatal occupational injuries: a synthesis of studies. *Am J Public Health.* 1991;81:725–728.
14. Bell CA, Stout NA, Bender TR, Conroy

CS. Crouse WE. Myers JR. Fatal occupational injuries in the United States, 1980 through 1985. *JAMA*. 1990;263:3047–3050.

15. Jenkins EL, Kisner SM. Fosbroke DE, et al. *Fatal Injuries to Workers in the United States, 1980–1989: A Decade of Surveillance: National Profile.* Washington, DC: US Government Printing Office; 1993. DHHS publication NIOSH 93-108.
16. *Child Labor Requirements in Nonagricultural Occupations under the Fair Labor Standards Act* (Child Labor Bulletin no. 101). Washington, DC: US Dept of Labor, Employment Standards Administration, Wage and Hour Division; 1990. WH publication 1330.
17. *Child Labor Requirements in Agriculture under the Fair Labor Standards Act* (Child Labor Bulletin no. 102). Washington, DC: US Dept of Labor, Employment Standards Administration, Wage and Hour Division; 1990. WH publication 1295.
18. *Sacrificing America's Youth: The Problem of Child Labor and the Response of Government.* Chicago, Ill: National Safe Workplace Institute; 1992.
19. *Child Labor: Increases in Detected Child Labor Violations throughout the United States.* Washington, DC: US General Accounting Office; 1990. Publication GAO/HRD-90-116.
20. Nelson RR. State labor legislation enacted in 1992. *Monthly Labor Rev.* 1993; 116:35–49.